

PATENT ABSTRACTS OF JAPAN

(11)Publication number : **2002-260910**

(43)Date of publication of application : **13.09.2002**

(51)Int.Cl. **H01F 1/16**

 B05D 5/12

 B05D 7/14

 B32B 15/08

 H01F 27/24

 // C09J 5/08

 C09J201/00

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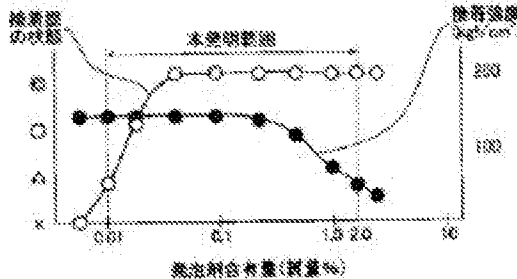
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(54) ELECTROMAGNETIC STEEL SHEET WITH INSULATING FILM OF GOOD ADHESION

(57)Abstract:

PROBLEM TO BE SOLVED: To provide electromagnetic steel sheets provided with insulating films which contain adhesive resin on their surfaces and can be bonded to the steel sheets by laminating and pressing while heating.

SOLUTION: This electromagnetic steel plate has an insulation film formed at least on its one surface, and the insulation film contains adhesive resin and foaming agent. Foaming agent of 0.01 to 2 pts.mass and adhesive resin of 100 pts.mass are contained in the insulation film.



DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the heating bond type magnetic steel sheet with insulating coating used as a material of a laminated iron core used for a rotation machine, a transformer, etc. This invention relates to a lamination magnetic steel sheet, laminated iron cores, and these manufacturing methods.

[0002]

[Description of the Prior Art] Conventionally, the iron core used for electric appliances, such as a rotation machine and a transformer, gave insulating coating for decreasing an eddy current to a magnetic steel sheet first, and pierced or carried out the shearing work of it, a large number were accumulated, and it was further manufactured by making it adhere with welding, caulking, or adhesives. However, the iron core edge part connected too hastily, and the problem that insulation falls, and the problem that magnetic properties deteriorated by heat distortion were among the methods to which it is made to adhere by welding. The problem that magnetic properties deteriorated by working distortion was among the methods to which it is made to adhere with caulking. Although there was no problem of degradation of magnetic properties which were mentioned above in the method to which it is made to adhere with adhesives not much, since it was necessary to apply adhesives for every one magnetic steel sheet, there were a problem that workability is bad, and a problem that the adhesive strength between insulating coatings was not enough.

[0003] On the other hand, the method of laminating and carrying out heat pressing of the steel plate produced by applying to JP,H2-208034,A the constituent which uses a

thermoplastic acrylic resin emulsion with a glass transition temperature of not less than 60 **, an epoxy resin emulsion, etc. as the main ingredients, and drying, and manufacturing a laminated iron core is indicated. This method skips the process of applying adhesives, cannot be easily influenced by working distortion, and has the advantage of being hard to block when it winds around a coiled form. However, in the actual laminated iron core produced by carrying out heat pressing of the magnetic steel sheet (henceforth "the conventional heating bond type magnetic steel sheet") manufactured with the described method, A portion with imperfect adhesion may exist, and when severe, there was a problem of causing the exfoliation between layers by an adhesive agent (exfoliation in respect of adhesion). When an iron core was large, it is easy to receive the influence of concavo-convex of a tunic and a steel plate, and was especially easy to actualize a problem.

[0004]It explains using figures. Drawing 1 is a typical sectional view of the insulating coating 2 containing adhesive resin in the laminated iron core 1 which laminates the conventional heating bond type magnetic steel sheet, and is produced by carrying out heat pressing. the delicate ridge by roping of the spreading roll at the time of spreading, etc. even if the surface of the insulating coating 2 completely looks flat on appearance before adhesion -- unevenness of the tunic of ** exists, and even if it performs heat pressing, the crevice may not paste up. As a result, the adhesion good portion 3 and the non adhesion portion 4 exist in the shape of stripes, and not resulting in full adhesion may arise. It becomes a cause of leakage when this wants to seal the inside and outside of the laminated core of the laminated iron core 1. A core crack may be caused in the portion it became insufficient for the Reasons of a board thickness deviation, a thickness deviation, etc. pressurizing, without insulating coating 2 comrades fully sticking. The core crack portion 5 is a portion which has caused exfoliation between layers. Unevenness of a board thickness deviation, a thickness deviation, and insulating coating, etc. surely exist, and on the other hand, since the pressure at the time of heat pressing cannot be enlarged on account of a device in many cases, either, a possibility that the above-mentioned problem will arise will remain in a actual product to some extent.

[0005]

[Problem(s) to be Solved by the Invention]Therefore, this invention is a magnetic steel sheet which has the insulating coating which contains adhesive resin on the surface. The purpose laminates, and when heat pressing is carried out, it is providing the magnetic steel sheet which these insulating coatings can fully paste up.

This invention is a lamination magnetic steel sheet which laminates two or more magnetic steel sheets. The purpose is to provide a lamination magnetic steel sheet which magnetic steel sheets have fully pasted up by the glue line containing the adhesive resin between each magnetic steel sheet, and a manufacturing method for the same.

This invention is a laminated iron core which laminates two or more magnetic steel sheets. The purpose is to provide a laminated iron core which magnetic steel sheets have fully pasted up by the glue line containing the adhesive resin between each magnetic steel sheet, and a manufacturing method for the same.

[0006]

[Means for Solving the Problem]When this invention person made adhesive resin which constitutes insulating coating contain a foaming agent of a specific amount as a result of

inquiring wholeheartedly that an aforementioned problem should be solved, a foaming agent foamed to him at the time of heat pressing, he found out that insulating coating expanded and a non adhesion portion did not arise, and completed this invention. [0007]That is, it is a magnetic steel sheet with insulating coating with which this invention provides insulating coating in at least one surface of a magnetic steel sheet, this insulating coating contains adhesive resin and a foaming agent, and content of this foaming agent provides a magnetic steel sheet with insulating coating which is 0.01 to 2 mass part to this adhesive resin 100 mass part. Drawing 2 is a cross section showing a state before and behind heat pressing of a lamination magnetic steel sheet which laminates a magnetic steel sheet with insulating coating of a lamination magnetic steel sheet which laminates the conventional heating bond type magnetic steel sheet and (a) (b) this invention which were mentioned above. A magnetic steel sheet with insulating coating of this invention is not limited to this. The conventional heating bond type magnetic steel sheet 10 which forms the adhesive resin tunic (insulating coating containing adhesive resin) 12 in the magnetic steel sheet 11 is laminated, if heat pressing is carried out, it will originate in unevenness of the adhesive resin tunic 12, and the adhesion good portion 13 and the non adhesion portion 14 will produce it. On the other hand, the magnetic steel sheet 20 with insulating coating of this invention which forms the insulating coating 22 which contains adhesive resin and a foaming agent in the magnetic steel sheet 21, It pastes up without laminating, and some or all of a foaming agent foaming with heating, and forming the air bubbles 23, and the insulating coating's 22 expanding by this and producing a crevice between insulating coating 22 comrades, if heat pressing is carried out. Therefore, according to the magnetic steel sheet with insulating coating of this invention, it laminates, and when heat pressing is carried out, insulating coatings can paste up closely enough.

[0008]This invention is a lamination magnetic steel sheet which laminates two or more magnetic steel sheets, it has a glue line which contains adhesive resin between each magnetic steel sheet, and this glue line provides a lamination magnetic steel sheet which has many air bubbles whose path is smaller than thickness of a glue line.

[0009]This invention is a laminated iron core which laminates two or more magnetic steel sheets, and provides a laminated iron core which has a glue line which contains adhesive resin between each magnetic steel sheet and in which this glue line has many air bubbles whose path is smaller than thickness of a glue line.

[0010]After laminating two or more this inventions so that said insulating coatings may paste up said magnetic steel sheet with insulating coating, heat pressing of them is carried out so that it may become the temperature more than degradation starting temperatures of said foaming agent, A manufacturing method of a lamination magnetic steel sheet obtaining a lamination magnetic steel sheet is provided by making some or all of said foaming agent foam.

[0011]After laminating two or more this inventions so that said insulating coatings may paste up said magnetic steel sheet with insulating coating, heat pressing of them is carried out so that it may become the temperature more than degradation starting temperatures of said foaming agent, A manufacturing method of a laminated iron core obtaining a laminated iron core is provided by making some or all of said foaming agent foam.

[0012]

[Embodiment of the Invention]Hereafter, this invention is explained in detail.

Introduction and the magnetic steel sheet with insulating coating of this invention are explained. The magnetic steel sheet with insulating coating of this invention is a magnetic steel sheet with insulating coating which provides insulating coating in at least one surface of a magnetic steel sheet, This insulating coating contains adhesive resin and a foaming agent, and content of this foaming agent is characterized by being 0.01 to 2 mass part to this adhesive resin 100 mass part.

[0013]A publicly known thing can be used as a magnetic steel sheet (electrical sheet) used for the magnetic steel sheet with insulating coating of this invention, and which thing may be sufficient as nondirectional, 1 directivity, 2-way nature, etc. The chemical composition in particular of a magnetic steel sheet is not limited. Although the board thickness in particular of a magnetic steel sheet is not limited, it is preferred to be referred to as about 0.05-1.0 mm which is the usual thickness.

[0014]The adhesive resin in particular used for this invention is not limited, but resin, such as acrylic, an epoxy system, a phenol system, and a silicone series, can be used for it, it is independent or these can be used for it as a mixture of two or more sorts of adhesive resin. Additives, such as an amine system hardening agent and silica, can be added in the range which does not spoil the effect of this invention. As for the adhesive resin used for this invention, it is preferred that glass transition temperature or softening temperature is not less than 60 **. When good adhesive strength is obtained as glass transition temperature or softening temperature is not less than 60 **, and it rolls round to a coiled form, blocking of steel plates can be controlled.

[0015]The foaming agent used for this invention is a chemical foaming agent, and generates gas, such as nitrogen, carbon dioxide, carbon monoxide, ammonia, and hydrogen, with heating. As a foaming agent, both an organic system foaming agent and an inorganic system foaming agent can be used. As an organic system foaming agent, for example AZOJI carvone amide, an azobis formamide, Azo compound;N,N'-dinitrosopentamethylenetetramines, such as azobisisobutyronitrile and azo JIKARUPON acid barium, Nitroso compounds, such as N, N'-dinitroso N, and N'-dimethylterephthalamide; Benzenesulphonyl Hydrazide, Sulfonyl semicarbazide compound;5-phenyltetrazoles, such as sulfonyl Hydrazide compound;p-toluene sulfonyl semicarbazide, such as p-tosyl Hydrazide and p,p'-oxyscrew benzenesulphonyl Hydrazide, Tetrazole compounds, such as 5-phenyl-1H-tetrazole, are mentioned. As an inorganic system foaming agent, what added organic acid is mentioned to azide compound; sodium borohydride;, such as sodium bicarbonate, ammonium carbonate, ammonium bicarbonate, ammonium nitrite, and calcium azido, and these, for example. These foaming agents are the ranges which do not spoil this invention, and it may be made to compound and they may be used.

[0016]In particular the degradation starting temperatures and decomposition temperature of a foaming agent are not limited. Here, the degradation starting temperatures and decomposition temperature in this invention are explained using drawing 3. Drawing 3 is a graph which shows the relation between the temperature at the time of heating a foaming agent by a part for heating-rate/of 2 **, and a gas yield. When it heats by a part for heating-rate/of 2 **, a gas yield is the temperature which begins to increase rapidly, and the degradation starting temperatures of the foaming agent in this invention are the temperature of the intersection of the tangent a and the tangent b in drawing 3. The decomposition temperature of the foaming agent in this invention is a temperature with

which a gas yield is saturated, when it heats by a part for heating-rate/of 2 **, and it is the temperature of the intersection of the tangent c and the tangent d in drawing 3.

[0017]The content of the foaming agent in the insulating coating of the magnetic steel sheet with insulating coating of this invention is 0.01 to 2 mass part to adhesive resin 100 mass part. The content of the foaming agent in insulating coating is the point of fully expanding insulating coating, is 0.01 or more mass parts to adhesive resin 100 mass part, and is 0.10 or more mass parts still more preferably 0.05 or more mass parts more preferably 0.02 or more mass parts. The content of the foaming agent in insulating coating is the point of maintaining the density of a tunic and maintaining adhesive strength, is two or less mass parts to adhesive resin 100 mass part, and is 1.0 or less mass parts more preferably 1.5 or less mass parts.

[0018]As for the magnetic steel sheet with insulating coating of this invention, in order to be used suitably for the lamination magnetic steel sheet of this invention and the laminated iron core of this invention which are mentioned later, it is preferred that a foaming agent distributes uniformly, makes air bubbles smaller than the thickness after adhesion generate, and gets into adhesive resin.

[0019]The insulating coating of the magnetic steel sheet with insulating coating of this invention can contain a decomposition accelerator (foaming auxiliary), in order to adjust the temperature characteristics about foaming of the above-mentioned foaming agent. Especially as a decomposition accelerator, it is not limited but a publicly known thing can be used according to the foaming agent used. For example, the metallic compounds which have urea, stearic acid, dibasic lead phthalate, dibasicity phosphorous acid lead, and Lewis acid are mentioned.

[0020]The insulating coating of the magnetic steel sheet with insulating coating of this invention can contain additive agents, such as a rust-proofer, in much more improvement sake in various performances. In this case, as for the total quantity of the mineral matter in insulating coating, in order to secure the performance after distortion picking annealing, it is preferred to consider it as three to 300 mass part to organic substance 100 mass part.

[0021]The thickness of the insulating coating of the magnetic steel sheet with insulating coating of this invention, It is preferred that it is 0.05 micrometers or more at the point that sufficient resistance between layers can be obtained although not limited in particular, It is more preferred that it is 0.1 micrometers or more, and in order to keep high a lamination factor (the ferrite to the whole case where it is considered as a lamination magnetic steel sheet or a laminated iron core comparatively), it is preferred that it is 25 micrometers or less, and it is more preferred that it is 10 micrometers or less.

[0022]The magnetic steel sheet with insulating coating in particular of this invention does not have a manufacturing method limited. For example, the adhesive resin of drainage systems, such as an emulsion and dispersion, is applied to a magnetic steel sheet by various methods, such as the roll coater method, the flow coater method, spray painting, and the knife coating-machine method, and the method of performing baking finish by methods which are usually enforced, such as a hot wind type, an infrared type, and an induction heating method, is mentioned. After these processes turn off the magnetic steel sheet and make it tabular, they may be performed, but it is [productivity] higher to perform them in the coiled state, and they are practical. Below the decomposition temperature of the foaming agent used performs these processes below with degradation

starting temperatures preferably. Thereby, foaming of the foaming agent in a manufacturing process can be controlled, and the foaming performance at the time of laminating and carrying out heat pressing of the magnetic steel sheet with insulating coating of this invention can be collateralized. Therefore, as for the magnetic steel sheet with insulating coating of this invention, at least some foaming agents have foaming performance.

[0023]Since it laminates, and it can paste up closely enough, without a foaming agent's foaming, expanding insulating coating and producing a crevice among insulating coatings when heat pressing is carried out, the magnetic steel sheet with insulating coating of this invention does not cause exfoliation between layers by an adhesive agent. In the magnetic steel sheet with insulating coating of this invention, since there is no problem that insulation falls or magnetic properties deteriorate by heat distortion or working distortion, in the case of manufacture and it is not necessary to apply adhesives to it further after insulating coating formation, the problem that it is bad does not have workability, either.

[0024]The magnetic steel sheet which has an electric insulation tunic produced by applying to JP,H4-235286,A the dichromic acid solution which blended the organic blowing agent etc. is indicated. A foaming agent is made to foam to this magnetic steel sheet at the time of film formation, and it produces uniform cellular structure in an insulating coating layer. However, in manufacturing a lamination magnetic steel sheet by laminating and carrying out heat pressing of this magnetic steel sheet, there is a problem of the adhesive agent produced from unevenness on the surface of a tunic, etc. like the conventional heating bond type magnetic steel sheet. On the other hand, since a foaming agent will foam to it, it will expand insulating coating and will not produce a crevice among insulating coatings if it laminates and heat pressing of it is carried out, since the magnetic steel sheet with insulating coating of this invention controls foaming in the time of film formation, etc. and collateralizes foaming performance, it does not have a problem of an adhesive agent.

[0025]Below, the lamination magnetic steel sheet of this invention is explained. The lamination magnetic steel sheet of this invention is a lamination magnetic steel sheet which laminates two or more magnetic steel sheets, it has a glue line which contains adhesive resin between each magnetic steel sheet, and this glue line has many air bubbles whose path is smaller than the thickness of a glue line. A glue line fully has intensity and the lamination magnetic steel sheet of this invention does not have problems, such as exfoliation between layers by an adhesive agent.

[0026]The magnetic steel sheet and adhesive resin which are used for the lamination magnetic steel sheet of this invention are the same as that of what is used for the magnetic steel sheet with insulating coating of this invention mentioned above. The glue line of the lamination magnetic steel sheet of this invention can contain additive agents, such as a rust-proofer, like the insulating coating of the magnetic steel sheet with insulating coating of this invention.

[0027]Although the thickness in particular of the glue line of the lamination magnetic steel sheet of this invention is not limited, it is the point that sufficient resistance between layers can be obtained, It is preferred that it is 0.05 micrometers or more, it is more preferred that it is 0.1 micrometers or more, and in order to keep a lamination factor high, it is preferred that it is 25 micrometers or less, and it is more preferred that it is 15 micrometers or less.

[0028]The glue line of the lamination magnetic steel sheet of this invention has many air bubbles whose path is smaller than the thickness of a glue line. Adhesive strength will become weak if the path of air bubbles is larger than the thickness of a glue line.

[0029]After laminating especially two or more lamination magnetic steel sheets of this invention so that a manufacturing method may not be limited, for example, said insulating coatings may paste up the magnetic steel sheet with insulating coating of this invention, heat pressing of them is carried out so that it may become the temperature more than the degradation starting temperatures of said foaming agent, The manufacturing method of the lamination magnetic steel sheet of this invention making some or all of said foaming agent foam is mentioned suitably. Hereafter, the manufacturing method of the lamination magnetic steel sheet of this invention is explained.

[0030]In the manufacturing method of the lamination magnetic steel sheet of this invention, two or more sheets are laminated so that said insulating coatings may paste up the magnetic steel sheet with insulating coating of this invention first. Here, when the magnetic steel sheet with insulating coating of this invention has insulating coating to both sides, the magnetic steel sheet with insulating coating of other this inventions can be laminated on the both sides. Therefore, desired number of sheets can be laminated by having insulating coating for magnetic steel sheets with insulating coating other than two sheets of the both ends to laminate to both sides.

[0031]Next, heat pressing is carried out so that it may become the temperature more than the degradation starting temperatures of said foaming agent, and some or all of said foaming agent is made to foam. It can be made to paste up, without expanding insulating coating and producing a crevice among insulating coatings by making a foaming agent foam and producing many air bubbles. In the manufacturing method of the lamination magnetic steel sheet of this invention, especially if cooking temperature is more than the degradation starting temperatures of the foaming agent used, it will not be limited, but it is preferred that it is more than the glass transition temperature of the adhesive resin used or softening temperature, and it is preferred that it is below the decomposition temperature of adhesive resin.

[0032]As for adhesion pressure, it is preferred that it is more than 0.01 kgf/cm^2 ($9.81 \times 10^2 \text{ Pa}$), It is more preferred that it is more than 1 kgf/cm^2 ($9.81 \times 10^4 \text{ Pa}$), It is preferred that it is especially more than 5 kgf/cm^2 ($4.90 \times 10^5 \text{ Pa}$), It is preferred that it is below 2000 kgf/cm^2 ($1.961 \times 10^8 \text{ Pa}$), it is more preferred that it is below 1000 kgf/cm^2 ($9.81 \times 10^7 \text{ Pa}$), and it is preferred that it is especially below 500 kgf/cm^2 ($4.90 \times 10^7 \text{ Pa}$). Since the insulating coating containing adhesive resin expands according to the manufacturing method of the lamination magnetic steel sheet of this invention, compared with the conventional heating bond type magnetic steel sheet, sufficient adhesion state is realizable with lower adhesion pressure. As for application-of-pressure time, it is preferred that it is 10 to 10000 seconds.

[0033]Although the use in particular of the lamination magnetic steel sheet of this invention is not limited, it is one of the modes with preferred considering it as a laminated iron core. That is, it is a laminated iron core which laminates two or more magnetic steel sheets, and the laminated iron core which has a glue line which contains adhesive resin between each magnetic steel sheet and in which this glue line has many air bubbles whose path is smaller than the thickness of a glue line is one mode of this

invention. Although it is preferred to carry out heat pressing and to block using an adhesive resin layer being shown in the surface as for the lamination magnetic steel sheet of this invention, it may use it, carrying out lamination adherence by others and a method (it crimps and welds), without carrying out heat pressing. Since the lamination magnetic steel sheet of this invention is obtained by laminating a magnetic steel sheet by heat pressing, even when carrying out lamination adherence of this by other methods, it pierces and there is an advantage that there is little time and effort of the number of times of lamination. Although the use in particular of the manufacturing method of the lamination magnetic steel sheet of this invention is not limited, it is one of the modes with preferred considering it as the manufacturing method of the laminated iron core of this invention. Namely, after laminating two or more sheets so that said insulating coatings may paste up the magnetic steel sheet with insulating coating of this invention, heat pressing is carried out so that it may become the temperature more than the degradation starting temperatures of said foaming agent, The manufacturing method of the lamination magnetic steel sheet obtaining a laminated iron core is one mode of this invention by making some or all of said foaming agent foam.

[0034]

[Example] Although working example is shown below and this invention is concretely explained to it, this invention is not restricted to these.

(Working example 1-18 and comparative examples 1-5) To the size of 150 mm x 300 mm, and the magnetic steel sheet (electrical sheet) of 0.5 mm of board thickness, as shown in the 1st table, The adhesive resin of various kinds of drainage systems which contain various kinds of foaming agents by predetermined content was applied by the roll coater, it printed and cooled radiationally by 180 ° of attainment board temperature, and the magnetic steel sheet with insulating coating which has the insulating coating of 5 micrometers of coating thickness on the surface of one side was obtained. After laminating two sheets next so that insulating coatings may paste up a magnetic steel sheet with insulating coating, carry out heat pressing, it was made to paste up with the temperature shown in the 1st table using a hotpress on pressure 10kgf/cm² (9.81x10⁵Pa) and the conditions for time 1 minute, and the lamination magnetic steel sheet was obtained.

[0035] Each magnetic steel sheet with insulating coating and each lamination magnetic steel sheet which were obtained were evaluated as follows.

(1) So that insulating coatings may paste up the magnetic steel sheet with insulating coating of two adhesive strength (20 mm[in width] x 70 mm in length) in the portion from a tip to 10 mm, It shifted, and after laminating (lap portion: 20 mm[in width] x 10 mm in length), carry out heat pressing, it was made to paste up at 200 ° using a hotpress on pressure 10kgf/cm² (9.81x10⁵Pa) and the conditions for time 1 minute, and the specimen was obtained. The maximum stress when it fractured by doing a tensile test at the room temperature on condition of speed-of-testing 3 mm/min about this specimen estimated adhesive strength.

[0036] (2) About the state lamination magnetic steel sheet (50 mm x 50 mm) of the adhesion side, drive a wedge between the pasted-up layers and it was made to exfoliate in respect of adhesion, and the state of the adhesion side was observed by viewing and evaluated as follows.

O : -- an almost whole surface product -- adhesion O: -- not less than 90% of area --

adhesion **: -- not less than 70% of less than 90% of area -- adhesion x: -- less than 70% of area pastes up [0037](3) Two magnetic steel sheets with insulating coating which while was obtained and have insulating coating on the surface by the airtight above, A total of 40 sheets with 38 magnetic steel sheets with insulating coating which have the insulating coating of 5 micrometers of coating thickness manufactured on the same conditions as the above on the surface of both, After piercing to ring shape (the outer diameter of 100 mm, and 50 mm in inside diameter), respectively, it laminated so that insulating coatings might paste up, and heat pressing was carried out on the same conditions as the above, and the laminated iron core was obtained. About each laminated iron core 30 which was typically shown in drawing 4 (a) below and which was obtained by the above, as it was shown in drawing 4 (b), the seal test was done. The seal of the upper surface and the undersurface of the laminated iron core 30 was carried out with the seals 31 and 32 made from stainless steel. However, the pipe 33 for sending air was attached to the seal 31 on top. Subsequently, the dipping of the laminated iron core 30 after a seal is carried out to the container into which the water 34 was put, From the pipe 33 attached to the seal 31 on top, compressed air was poured in so that a pressure might maintain 1 kgf/cm^2 ($9.81 \times 10^4 \text{ Pa}$), the air 35 which leaked per unit time from the side of the laminated iron core 30 was accumulated in the measuring cylinder 36, and the quantity was measured. In the examination about which laminated iron core 30, air had not leaked from between the laminated iron core 30 and the up-and-down seals 31 and 32.

[0038]The state and the airtight evaluation result of adhesive strength and an adhesion side are shown in the 1st table. About the thing (working example 1-8 and comparative examples 2 and 3) using acrylic resin containing 5-phenyltetrazole, the state of adhesive strength and an adhesion side was shown also in drawing 5. When the magnetic steel sheet with insulating coating of this invention (working example 1-18) was laminated, and heat pressing of it is carried out, it is pasted up and it is considered as the laminated iron core of the lamination magnetic steel sheet of this invention, or this invention, each is excellent in an adhesive property, and it turns out that the state of an adhesion side is good, so that clearly from the 1st table and drawing 5. After making [magnetic steel sheet / of working example 1-18 / lamination] a glue line exfoliate in respect of adhesion, when the section was observed with the electron microscope, the glue line had many air bubbles whose path is smaller than the thickness of a glue line in each case. On the other hand, the conventional heating bond type magnetic steel sheet (comparative examples 1, 4, and 5) with which adhesive resin does not contain a foaming agent had the bad adhesive property, and there were many non adhesion portions. It was also the same as when there is too little content of a foaming agent (comparative example 2). When there was too much content of a foaming agent (comparative example 3), it was inferior to adhesive strength.

[0039]

[Table 1]

第 1 表 (その1)

	接 着 性 樹 脂	発 泡 剤			接 着 度 (℃)	接 着 強 度		接 着 面 状 態	気密性 (mL/min)
		種 類	分解開始 温度 (℃)	添 加 量 (接着性樹脂100 質量部に対する質量部)		(kgf/cm ²)	(MPa)		
比較例 1	アクリル系樹脂	なし	—	0.00	250	135	13.2	×	10
比較例 2	アクリル系樹脂	5-フェニルテトラゾール	220	0.005	250	135	13.2	×	11
実施例 1	アクリル系樹脂	5-フェニルテトラゾール	220	0.01	250	135	13.2	△	5
実施例 2	アクリル系樹脂	5-フェニルテトラゾール	220	0.02	250	135	13.2	○	1
実施例 3	アクリル系樹脂	5-フェニルテトラゾール	220	0.05	250	132	12.9	◎	0.1
実施例 4	アクリル系樹脂	5-フェニルテトラゾール	220	0.10	250	132	12.9	◎	0
実施例 5	アクリル系樹脂	5-フェニルテトラゾール	220	0.20	250	130	12.7	◎	0
実施例 6	アクリル系樹脂	5-フェニルテトラゾール	220	0.50	250	110	10.8	◎	0
実施例 7	アクリル系樹脂	5-フェニルテトラゾール	220	1.00	250	71	6.96	◎	0
実施例 8	アクリル系樹脂	5-フェニルテトラゾール	220	2.00	250	52	5.10	◎	0
比較例 3	アクリル系樹脂	5-フェニルテトラゾール	220	3.00	250	29	2.84	◎	0

第 1 表 (その 2)

	接 着 性 樹 脂	発 泡 剤			接 着 度 (℃)	接 着 度		接 着 面 状 態	気 密 性 (mL/min)
		種 類	分解開始温度 (℃)	添 加 量 (接 着 性 樹 脂 100 質 量 部 に 対 す る 質 量 部)		(kgf/cm ²)	(MPa)		
実施例 9	アクリル系樹脂	p-tertブチルフェニルエーテルビス(4-tertブチルフェニル)エーテル	220	0.20	250	133	13.0	◎	0
実施例 10	アクリル系樹脂	p-tertブチルフェニルエーテルビス(4-tertブチルフェニル)エーテル	220	0.50	250	125	12.3	◎	0
実施例 11	アクリル系樹脂	p-tertブチルフェニルエーテルビス(4-tertブチルフェニル)エーテル	220	1.00	250	91	8.92	◎	0
実施例 12	アクリル系樹脂	重碳酸ナトリウム	200	0.20	230	134	13.1	◎	0
実施例 13	アクリル系樹脂	重碳酸ナトリウム	200	0.50	230	128	12.6	◎	0
実施例 14	アクリル系樹脂	重碳酸ナトリウム	200	1.00	230	100	9.81	◎	0
比較例 4	エポキシ系樹脂	な し	—	0.00	250	132	12.9	×	10
実施例 15	エポキシ系樹脂	5-フェニルテトラゾール	220	0.20	250	127	12.5	◎	0
実施例 16	エポキシ系樹脂	5-フェニルテトラゾール	220	0.50	250	118	11.6	◎	0
比較例 5	アクリル/エポキシ系樹脂	な し	—	0.00	250	134	13.1	×	10
実施例 17	アクリル/エポキシ系樹脂	5-フェニルテトラゾール	220	0.20	250	132	12.9	◎	0
実施例 18	アクリル/エポキシ系樹脂	5-フェニルテトラゾール	220	0.50	250	114	11.2	◎	0

[0041]The presentation of each adhesive resin is as follows among the 1st table.

Acrylic resin : ** Acrylic resin 85 mass % (glass transition temperature of 80 **), Epoxy-resin 15 mass %** epoxy system resin: Epoxy resin 85 mass % (softening temperature of

70 **), phenol resin 15 mass %** acrylic / epoxy-system-resin:acrylic resin 40 mass % (glass transition temperature of 80 **), epoxy resin 30 mass % (softening temperature of 70 **), phenol resin 30 mass % [0042]

[Effect of the Invention]The magnetic steel sheet with insulating coating of this invention is laminated, and when heat pressing is carried out, insulating coatings can paste it up closely enough. The lamination magnetic steel sheet of this invention and the laminated iron core of this invention are excellent in the adhesive property in a glue line. According to the manufacturing method of the lamination magnetic steel sheet of this invention, and the manufacturing method of the laminated iron core of this invention, the lamination magnetic steel sheet of this invention and the laminated iron core of this invention can be manufactured suitably.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a typical sectional view of the insulating coating containing adhesive resin in the laminated iron core which laminates the conventional heating bond type magnetic steel sheet, and is produced by carrying out heat pressing.

[Drawing 2](a) is a cross section showing the state before and behind the heat pressing of the lamination magnetic steel sheet which laminates the conventional heating bond type magnetic steel sheet, and (b) is a cross section showing the state before and behind the heat pressing of the lamination magnetic steel sheet which laminates the magnetic steel sheet with insulating coating of this invention.

[Drawing 3]It is a graph which shows the relation between the temperature at the time of heating a foaming agent by a part for heating-rate/of 2 **, and a gas yield.

[Drawing 4](a) is a typical perspective view of a laminated iron core, and (b) is an explanatory view of the seal test of a laminated iron core.

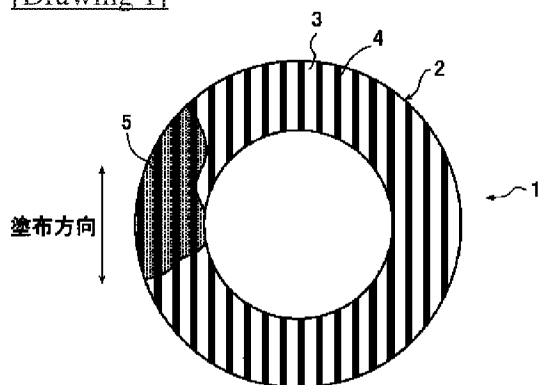
[Drawing 5]It is a figure showing a relation with each of the state of the foaming agent content in a part of working example of this invention, and comparative example, adhesive strength, and an adhesion side.

[Description of Notations]

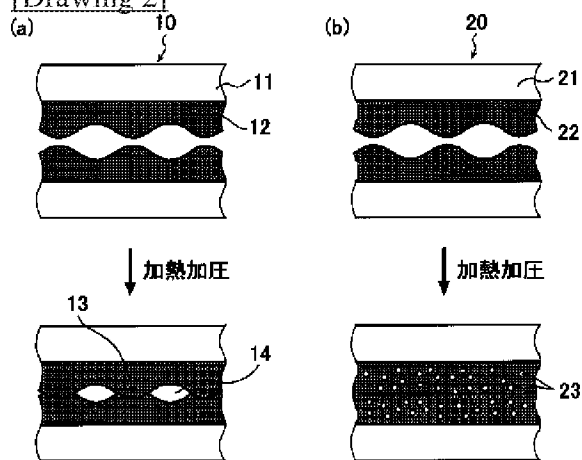
- 1 Laminated iron core
- 2 and 12 Adhesive resin tunic (insulating coating containing adhesive resin)
- 3 and 13 Adhesion good portion
- 4 and 14 Non adhesion portion
- 5 Core crack portion
- 10 The conventional heating bond type magnetic steel sheet
- 11 and 21 Magnetic steel sheet
- 20 The magnetic steel sheet with insulating coating of this invention
- 22 Insulating coating containing adhesive resin and a foaming agent
- 23 Air bubbles
- 30 Laminated iron core
- 31 A seal on top
- 32 A seal at the bottom
- 33 Pipe
- 34 Water
- 35 Air which leaked

DRAWINGS

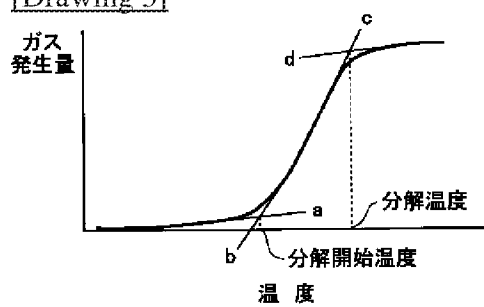
[Drawing 1]



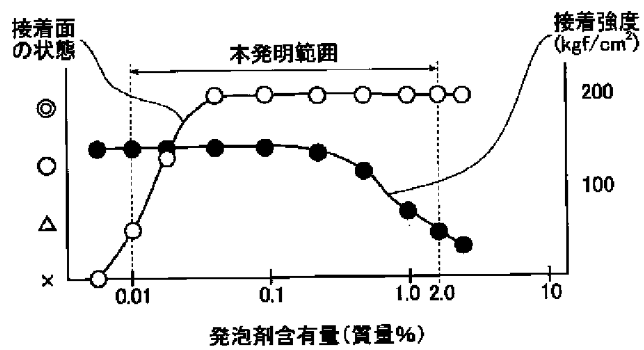
[Drawing 2]



[Drawing 3]



[Drawing 5]



[Drawing 4]

